Quotes from NWNH

From the NWNH Report

- Two complementary approaches to understanding dark energy have been considered by this survey: one on the ground and the other in space.
  - On the ground, the proposed LSST would provide optical imaging of brighter galaxies over half the sky every few days. It would build up measurements of galaxy images that are distorted by (weak) gravitational lensing and detect many relatively nearby supernovas.
  - From space, the proposed WFIRST would produce near-infrared images of fainter galaxies over smaller areas and observe distant supernovas. It would also provide near-infrared spectroscopy for sensitive baryon acoustic oscillation measurements. …
  - LSST and WFIRST will actually be quite synergistic, and observations from one are essential to interpreting the results of the other. In particular, by working together, they would provide the powerful color information needed for redshift estimation

From the NWNH Report

- To measure the properties of dark energy, WFIRST will employ three different techniques:
  - it will image about 2 billion galaxies and carry out a detailed study of weak lensing that will provide distance and rate-of-growth information;
  - it will measure spectra of about 200 million galaxies in order to monitor distances and expansion rate using baryon acoustic oscillations; and finally,
  - it will detect about 2,000 distant supernova explosions, which can be used to measure distances.
- JDEM-Omega RFI design provided the following:
  - ~1B or ~0.7B galaxies for 9,900 deg^2 or 6,600 deg^2 of WL
  - ~80M or ~100M spectra for 16,800 deg^2 or 20,400 deg^2 of BAO
  - 1,500 SNe

From the EOS Panel Report

- Observing in the near-IR from space offers powerful advantages, especially in the $1 < z < 2$ redshift range where these cosmological measurements are most effective.

- An exoplanet microlensing program requires continuous monitoring of a few fields containing tens of millions of stars in the galactic bulge for long contiguous periods. In the optimistic scenario that every star has an Earth-like planet, a 500-day microlensing campaign (spread over the first 5 years of the mission) would find ~200 Earth-mass planets.

From the EOS Panel Report

- In order to contain the cost and risk of this facility, however, the panel recommends that the architecture of JDEM/Omega be adopted and modified only as is necessary to optimize the two core programs of cosmic acceleration and the microlensing search for planets.
- Mindful of the priority of these two programs, planning for the operation of WFIRST should incorporate broader interests, including those of galactic and extragalactic surveys, stellar populations, and diverse GO programs: the panel imagines a newly appointed science working group to address these issues.
- In summary, the design of the telescope, spacecraft, and focal plane instrumentation should be left to the Project and focused around the programs of cosmic acceleration and microlensing planet finding, with the science working group helping to construct an operating plan for the facility that can accomplish the combination of the two dedicated programs with surveys and pointed observations.

From the EOS Panel Report

- Mechanisms for exchanging filters and grisms should be the only moving parts in the instrument. Imaging pixels should be no larger than 0.18-arcseconds. This will critically sample the diffraction-limited point-spread-function at λ = 2.1mm wavelength; next generation HgCdTe detectors, if available, will have smaller 15μm pixels that would lower the wavelength of diffraction limited sampling to λ = 1.7mm.

- The panel strongly discourages additional instrumentation, such as optical imaging with CCDs (for which the advantage of space is far smaller than for the near-IR), coronographs, integral field units, etc. Observing modes other than the "staring" imaging mode described here would increase complexity, cost, and management problems, disproportionate with any benefits.

- The panel notes that JDEM/IDECS, basically WFIRST (or JDEM/Omega) but including a CCD array camera, *was not ranked highly* by the panel for such reasons.

From the EOS Panel Report

- As a strawman example of how the first 5 years of a 10-year mission might be allocated, the panel imagines
  - 2+ years dedicated to the cosmic acceleration program. These observations will provide over 8000 sq deg for the BAO survey (grism) and 4000 sq deg for the weak lensing (single band imaging) survey (about half of the JDEM/Omega program), and produce a large multi-band galaxy survey for public archives.2 (The weak lensing/ galaxy survey could be interleaved with about half-a-year's worth of repeated observations of polar fields to monitor high-redshift supernovae.)
  - Dedicated microlensing campaigns of 100-days in each of the 5 years could accumulate a significant sample, even within the first few years of the mission.
  - A galactic plane survey of one-half year, together with about
  - 1 year allocated by open competition, would fill the initial 5 year timeline.

- Barring any operational problems, WFIRST should continue for another 5 years: peer review would compete augmentations of the cosmic acceleration or planet survey programs with new or larger surveys and smaller GO programs.

Backup Slides

From the NWNH Report

- A 1.5-meter wide-field-of-view near-infrared-imaging and low-resolution-spectroscopy telescope, WFIRST will settle fundamental questions about the nature of dark energy... It will employ three distinct techniques—measurements of weak gravitational lensing, supernova distances, and baryon acoustic oscillations—to determine the effect of dark energy on the evolution of the universe. An equally important outcome will be to open up a new frontier of exoplanet studies by monitoring a large sample of stars in the central bulge of the Milky Way for changes in brightness due to microlensing by intervening solar systems. It will also, in guest investigator mode, survey our galaxy and other nearby galaxies to answer key questions about their formation and structure, and the data it obtains will provide fundamental constraints on how galaxies grow.
- …An extended mission, subject to the usual senior review process, could both improve the statistical results for the main science drivers and broaden the general investigator program.

From the NWNH Report

- The committee considers the GI program to be an essential element of the mission, but firmly believes it should not drive the mission hardware design or implementation cost.

From the EOS Panel Report

- Observing in the near-IR from space offers powerful advantages, especially in the $1 < z < 2$ redshift range where these cosmological measurements are most effective. This includes the better angular resolution for defining galaxy shapes (weak lensing) and the accessiblility of the Hα emission line of hydrogen gas for redshift measurements (BAO) over the maximum volume that can be targeted. Why should WFIRST do all three methods? Supernovas give the best measurements … at low redshift. BAO excels over large volumes at higher redshift. …. Weak lensing makes a complementary measurement through the growth of structure.

From the Panels Report

- Weak lensing and cluster surveys provide independent measurements of D(z), and they provide the G(z) constraints needed to test modified gravity models. The galaxy redshift surveys designed for BAO studies can also measure G(z) through redshift-space distortions, the apparent anisotropy of structure induced by galaxy peculiar velocities. Recent theoretical work suggests that redshift-space distortions could be competitive with weak-lensing measurements of structure growth, but the systematic uncertainties of this method have not yet been explored.

- Theoretical advances often amplify the scientific return of a dataset or experiment well beyond its initial design. Potentially powerful techniques that are subjects of active theoretical scrutiny include redshift-space distortions as a precision measure of structure growth and scale-dependent galaxy bias as a sensitive probe of primordial non-Gaussianity. As data come in, theory assumes the pivotal role in tying them back to the underlying physics, whether it be computer models of core-collapse supernovae, phase transitions in the early universe, or extensions of the standard model of particle physics. Finally, more speculative, exploratory theory may produce the breakthrough that leads to a natural explanation of cosmic acceleration, a compelling physical mechanism for inflation, or the prediction of an extraordinary gravitational wave phenomenon yet to be observed.